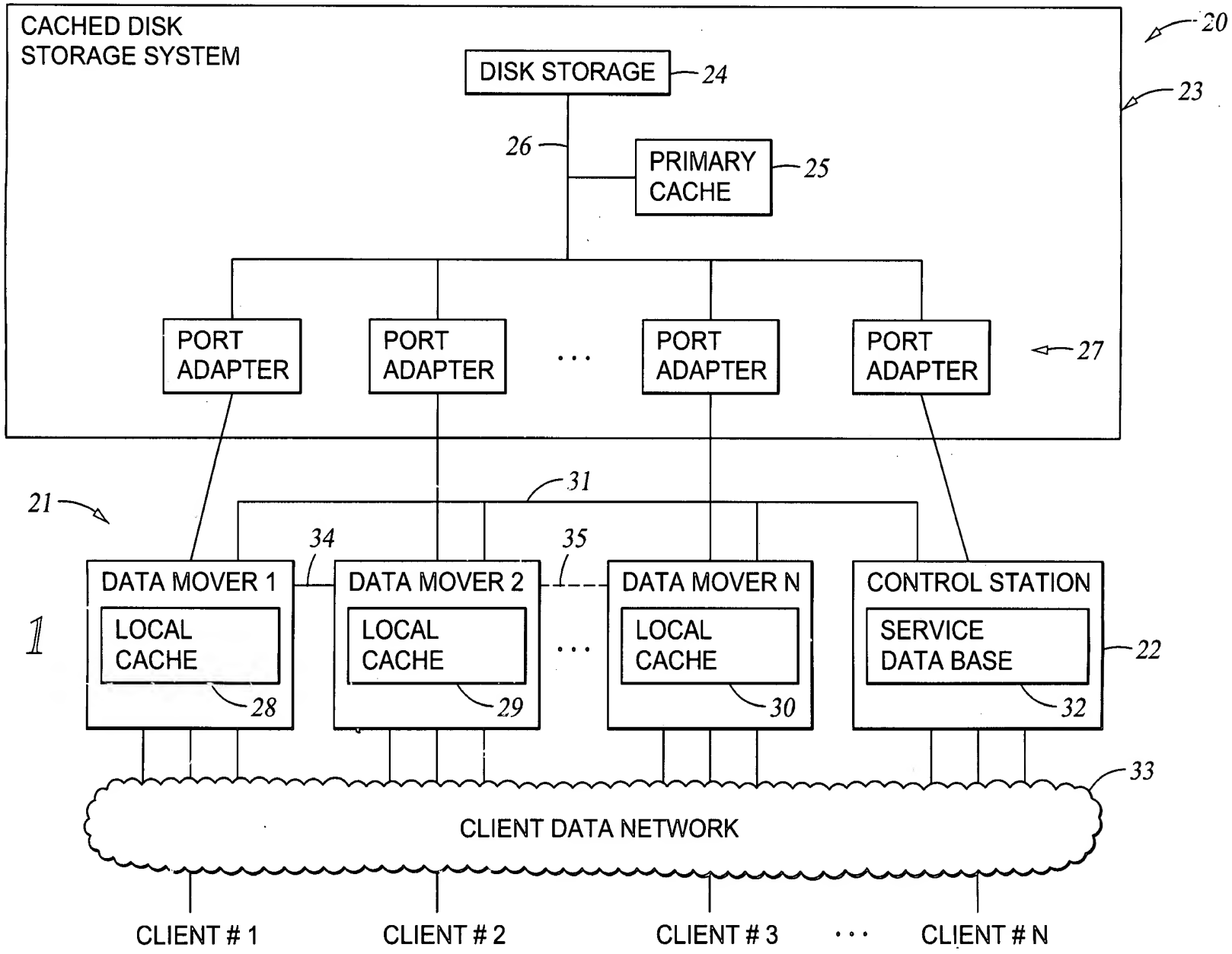

CACHED DISK
STORAGE SYSTEM
20
DISK STORAGE
24
23
26
PRIMARY
CACHE
25
PORT
ADAPTER
PORT
ADAPTER
PORT
ADAPTER
PORT
ADAPTER
27
21
31
34
35
DATA MOVER 1
LOCAL
CACHE
28
DATA MOVER 2
LOCAL
CACHE
29
DATA MOVER N
LOCAL
CACHE
30
CONTROL STATION
SERVICE
DATA BASE
32
22
33
CLIENT DATA NETWORK
CLIENT # 1
CLIENT # 2
CLIENT # 3
CLIENT # N

Fig. 1

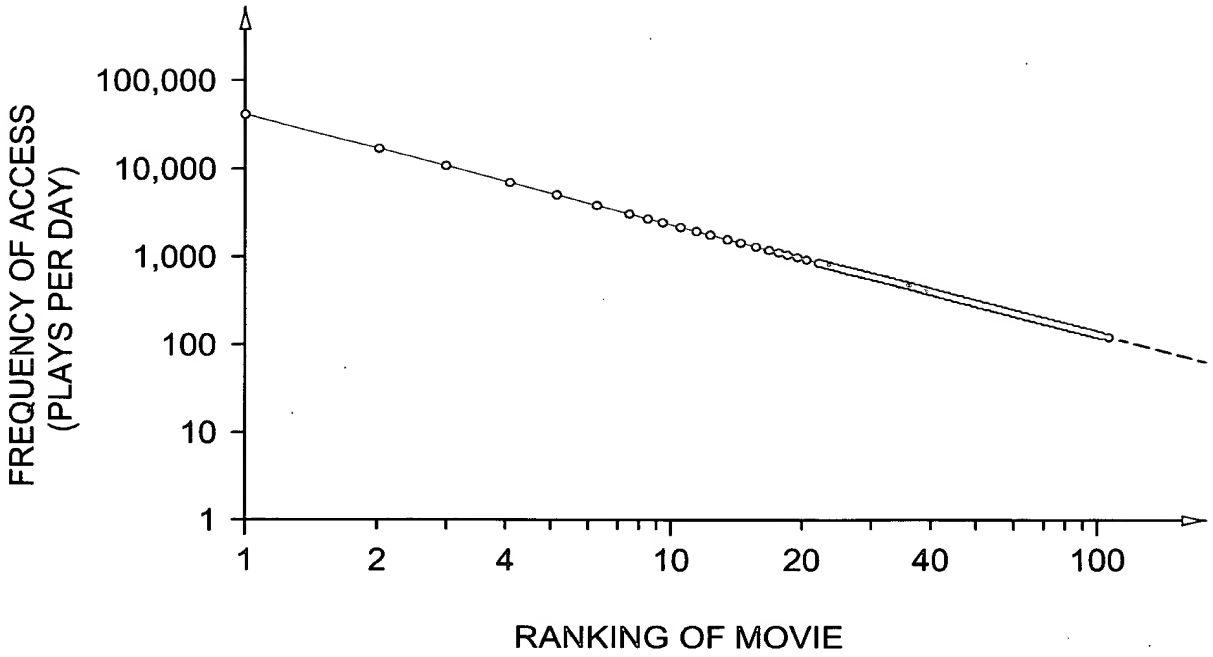


Fig. 2

MOVIE RANKING	DATA MOVER SET
1	SET 1 = {DM1, DM2, DM3}
2	SET 2 = {DM3, DM4}
3	SET 3 = {DM5}
4	SET 3 = {DM6}
5	SET 4 = {DM7}
6	SET 4 = {DM7}
7	SET 5 = {DM8}
8	SET 5 = {DM8}
⋮	⋮

Fig. 3

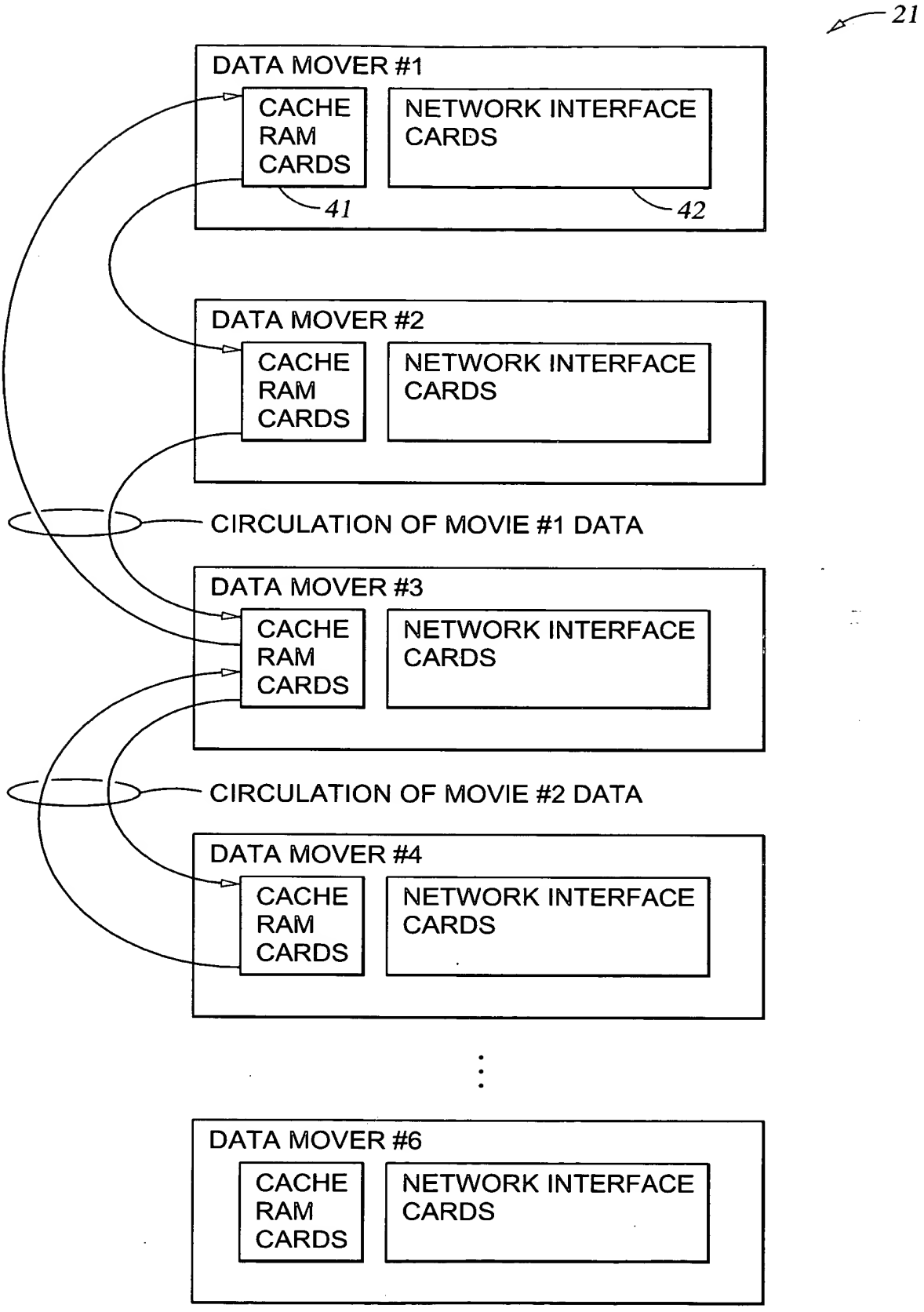

21
DATA MOVER #1
CACHE RAM CARDS
NETWORK INTERFACE CARDS
41
42
DATA MOVER #2
CACHE RAM CARDS
NETWORK INTERFACE CARDS
CIRCULATION OF MOVIE #1 DATA
DATA MOVER #3
CACHE RAM CARDS
NETWORK INTERFACE CARDS
CIRCULATION OF MOVIE #2 DATA
DATA MOVER #4
CACHE RAM CARDS
NETWORK INTERFACE CARDS
DATA MOVER #6
CACHE RAM CARDS
NETWORK INTERFACE CARDS

Fig. 4

MOVIE RANKING	MOVIE TITLE	FREQUENCY OF ACCESS	DATA MOVER SET	NO. OF RESERVED VIDEO STREAMS	NO. OF ACTIVE VIDEO STREAMS	LOCATION ON DISK	ANY LOCATION IN CACHE
1	---	25,000	1	5,000	3,497	---	---
2	---	11,000	2	2,200	1,738	---	---
3	---	7,900	3	1,580	2,300	---	---
4	---	6,900	3	1,380	790	---	---
5	---	4,000	4	800	570	---	---
6	---	2,600	4	520	640	---	---
7	---	2,300	4	460	198	---	---
8	---	2,000	4	400	340	---	---
9	---	1,700	5	340	270	---	---

Fig. 5

Fig. 6

AVAILABLE STREAMS FROM DATA MOVER SET

RESERVED	NOT RESERVED

ACTIVE	INACTIVE

BANDWIDTH ON STORAGE SYSTEM BUS

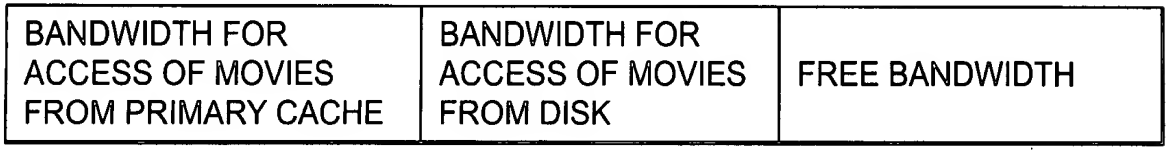


Fig. 7

PRIMARY CACHE MEMORY CAPACITY

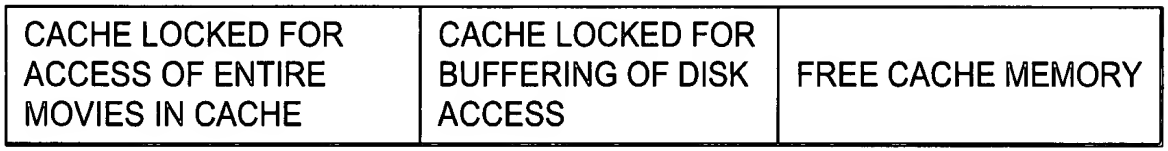


Fig. 8

PRIMARY CACHE LOCKED FOR ACCESS OF ENTIRE MOVIE IN CACHE

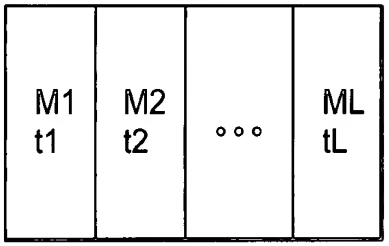


Fig. 9

AVAILABILITY OF MOVIE TITLES

SHOW AVAILIABILITY OF THE MOVIE TITLED:
_____(MOVIE TITLE SUPPLIED BY CLIENT)_____

LISTING IN RANK ORDER OF ACCESS AT ANY TIME MOVIES WITH FULL VCR CAPABILITY

LISTING IN RANK ORDER OF MOVIES SCHEDULED TO START IN NEXT 15 MINUITES

LISTING IN RANK ORDER OF MOVIES SCHEDULED TO START IN NEXT 30 MINUITES

LISTING IN RANK ORDER OF MOVIES SCHEDULED TO START IN NEXT 105 MINUTES

SHOW LISTING IN RANK ORDER OF MOVIES CURRENTLY PLAYING

SHOW LISTING OF OTHER MOVIE TITLES IN DISK STORAGE

SHOW LISTING OF ALL MOVIE TITLES IN ARCHIVE STORAGE

Fig. 10

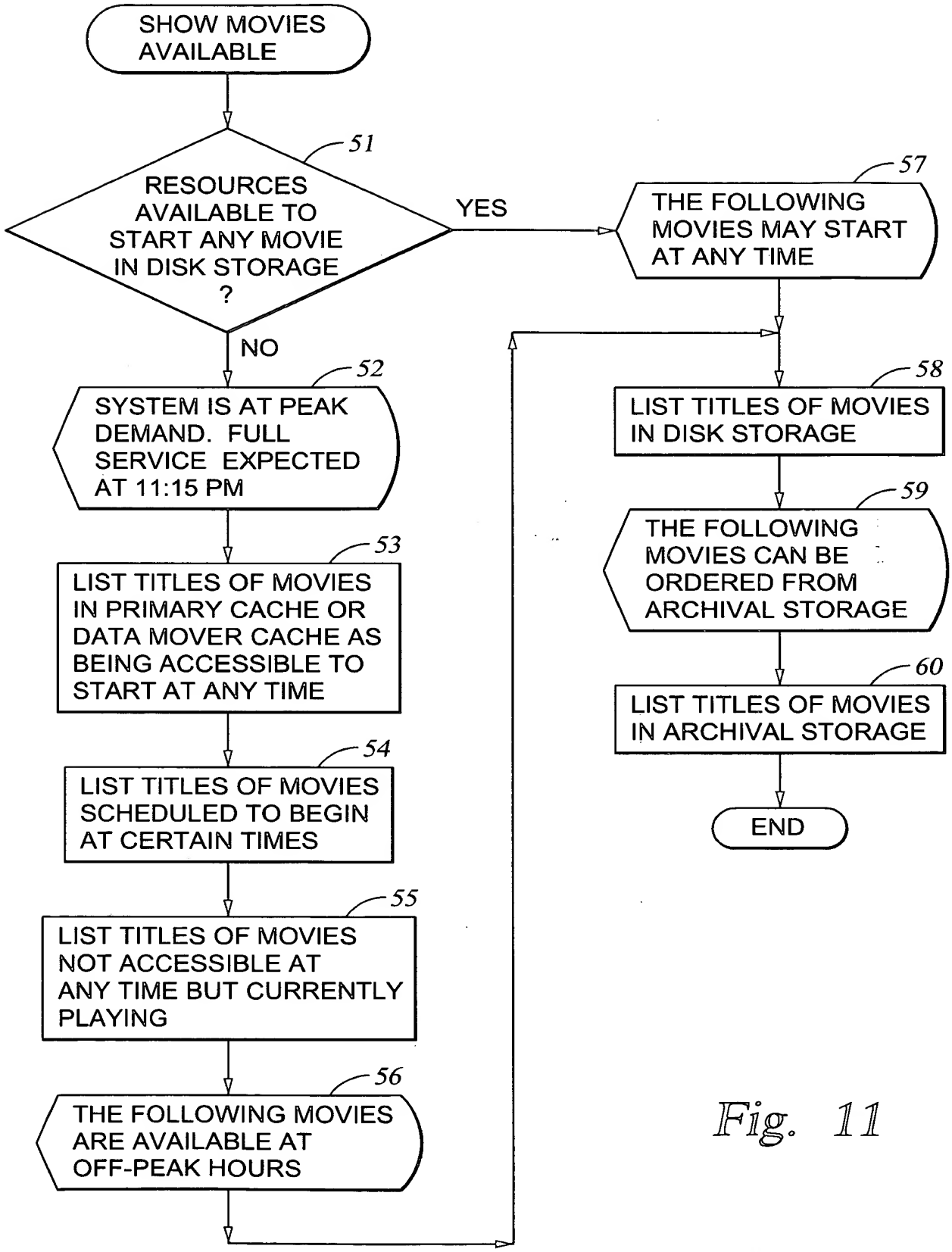

SHOW MOVIES AVAILABLE
51
RESOURCES AVAILABLE TO START ANY MOVIE IN DISK STORAGE ?
YES
NO
57
THE FOLLOWING MOVIES MAY START AT ANY TIME
52
SYSTEM IS AT PEAK DEMAND. FULL SERVICE EXPECTED AT 11:15 PM
53
LIST TITLES OF MOVIES IN PRIMARY CACHE OR DATA MOVER CACHE AS BEING ACCESSIBLE TO START AT ANY TIME
54
LIST TITLES OF MOVIES SCHEDULED TO BEGIN AT CERTAIN TIMES
55
LIST TITLES OF MOVIES NOT ACCESSIBLE AT ANY TIME BUT CURRENTLY PLAYING
56
THE FOLLOWING MOVIES ARE AVAILABLE AT OFF-PEAK HOURS
58
LIST TITLES OF MOVIES IN DISK STORAGE
59
THE FOLLOWING MOVIES CAN BE ORDERED FROM ARCHIVAL STORAGE
60
LIST TITLES OF MOVIES IN ARCHIVAL STORAGE
END

Fig. 11

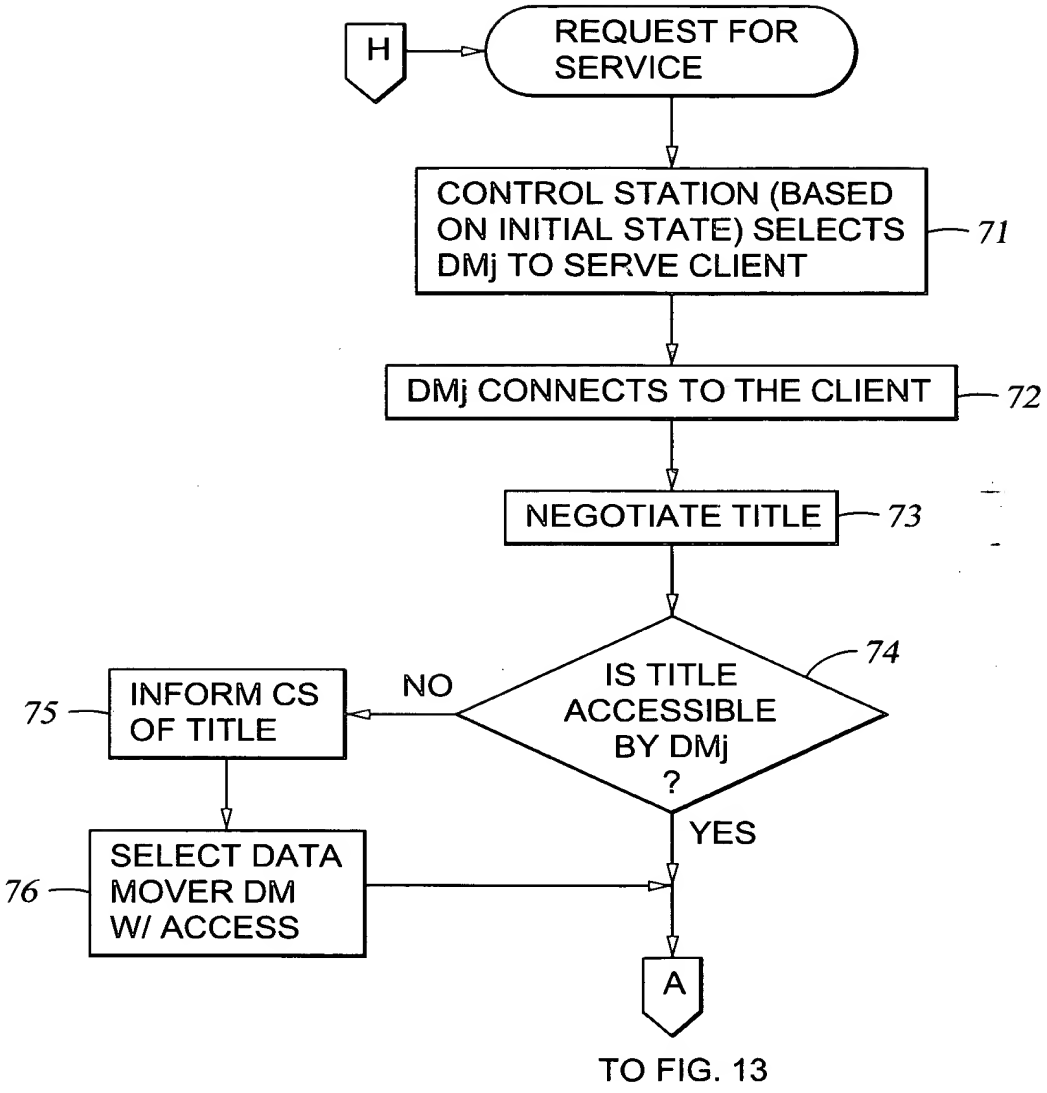

H
REQUEST FOR SERVICE
CONTROL STATION (BASED ON INITIAL STATE) SELECTS DMj TO SERVE CLIENT
71
DMj CONNECTS TO THE CLIENT
72
NEGOTIATE TITLE
73
IS TITLE ACCESSIBLE BY DMj ?
74
NO
INFORM CS OF TITLE
75
YES
SELECT DATA MOVER DM W/ ACCESS
76
A
TO FIG. 13

Fig. 12

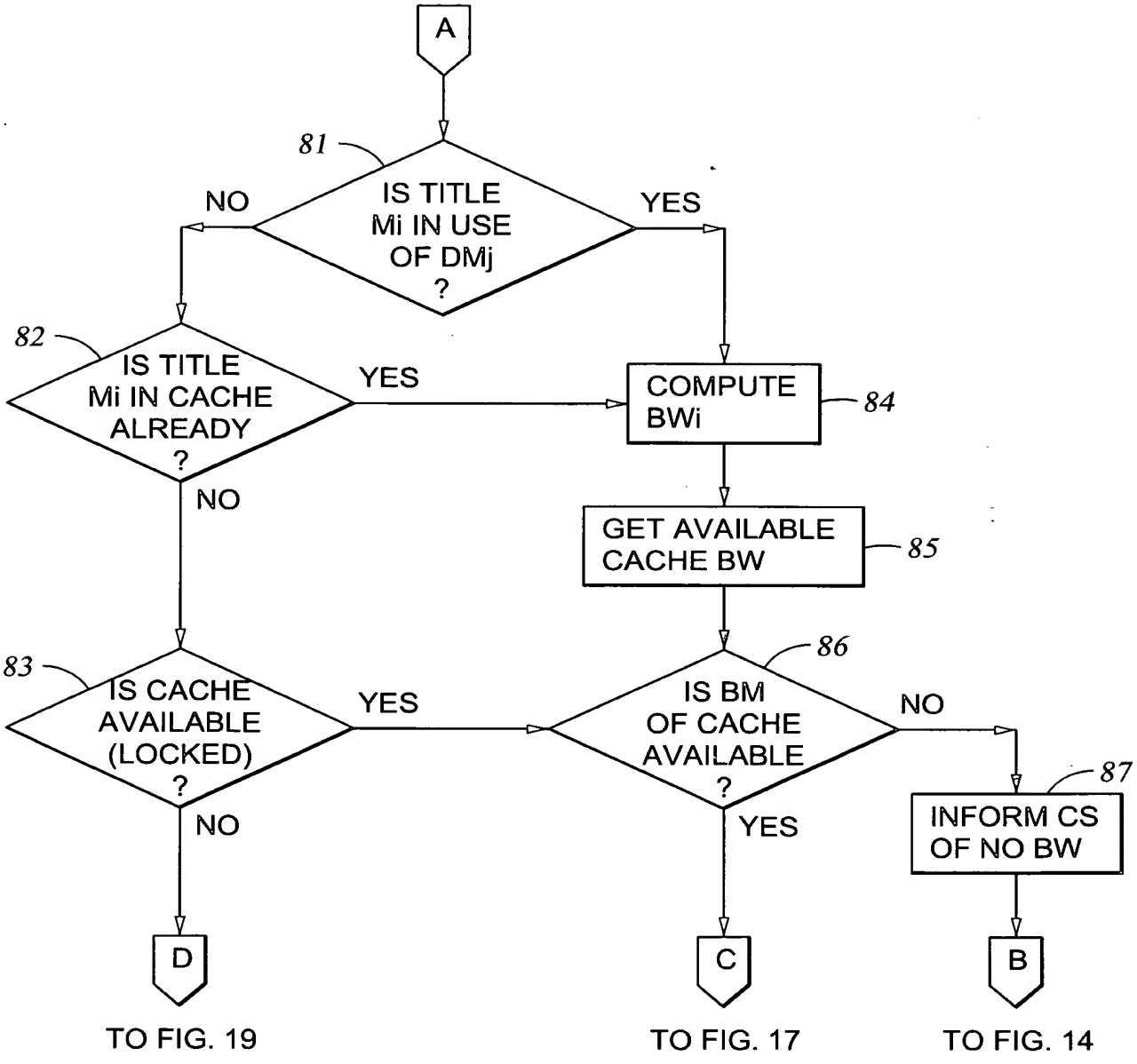

A
81
IS TITLE Mi IN USE OF DMj ?
NO
YES
82
IS TITLE Mi IN CACHE ALREADY ?
YES
COMPUTE BWi
84
NO
GET AVAILABLE CACHE BW
85
86
83
IS CACHE AVAILABLE (LOCKED) ?
YES
IS BM OF CACHE AVAILABLE ?
NO
87
INFORM CS OF NO BW
NO
YES
D
C
B
TO FIG. 19
TO FIG. 17
TO FIG. 14

Fig. 13

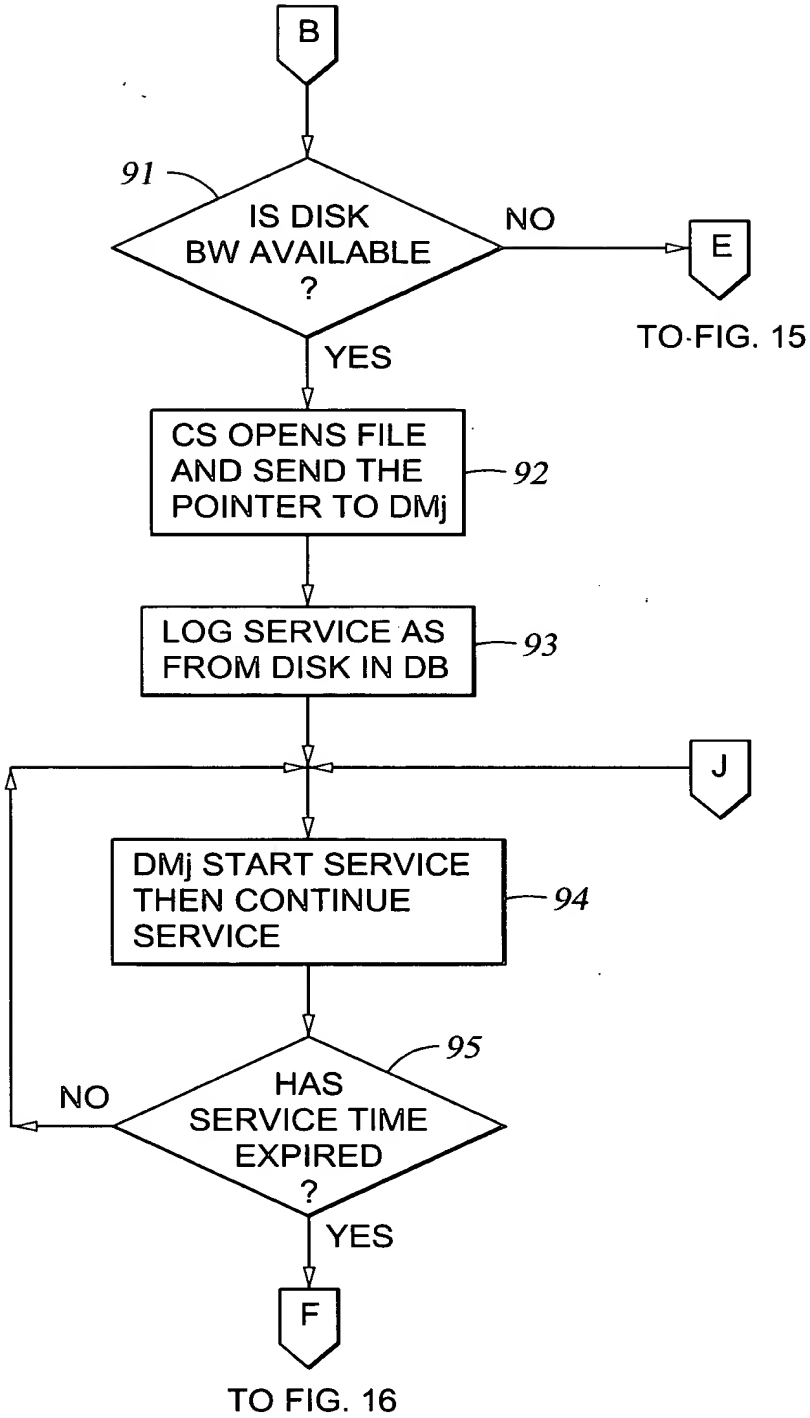

B
91
IS DISK BW AVAILABLE ?
NO
E
TO FIG. 15
YES
CS OPENS FILE AND SEND THE POINTER TO DMj
92
LOG SERVICE AS FROM DISK IN DB
93
J
DMj START SERVICE THEN CONTINUE SERVICE
94
95
HAS SERVICE TIME EXPIRED ?
NO
YES
F
TO FIG. 16

Fig. 14

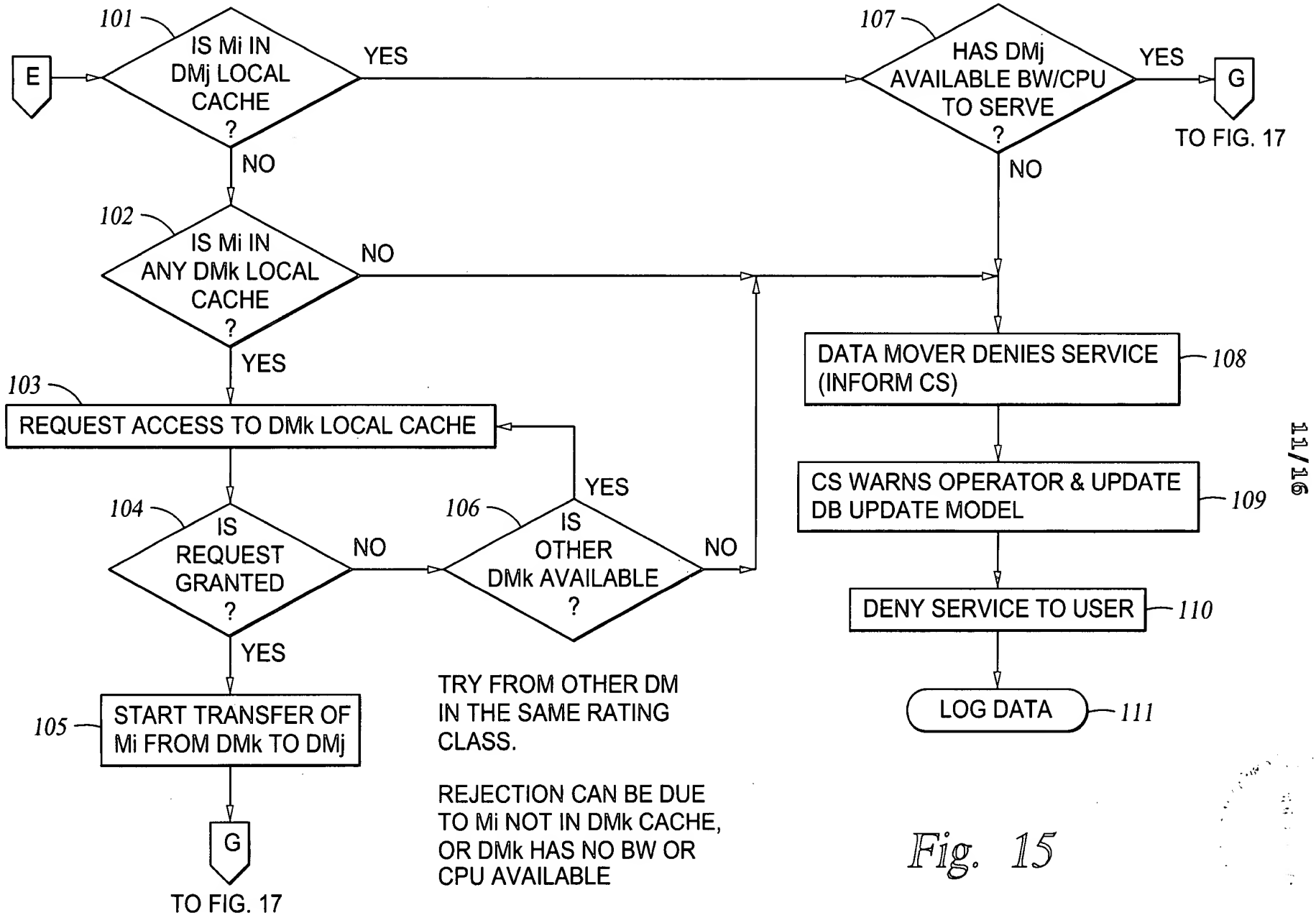
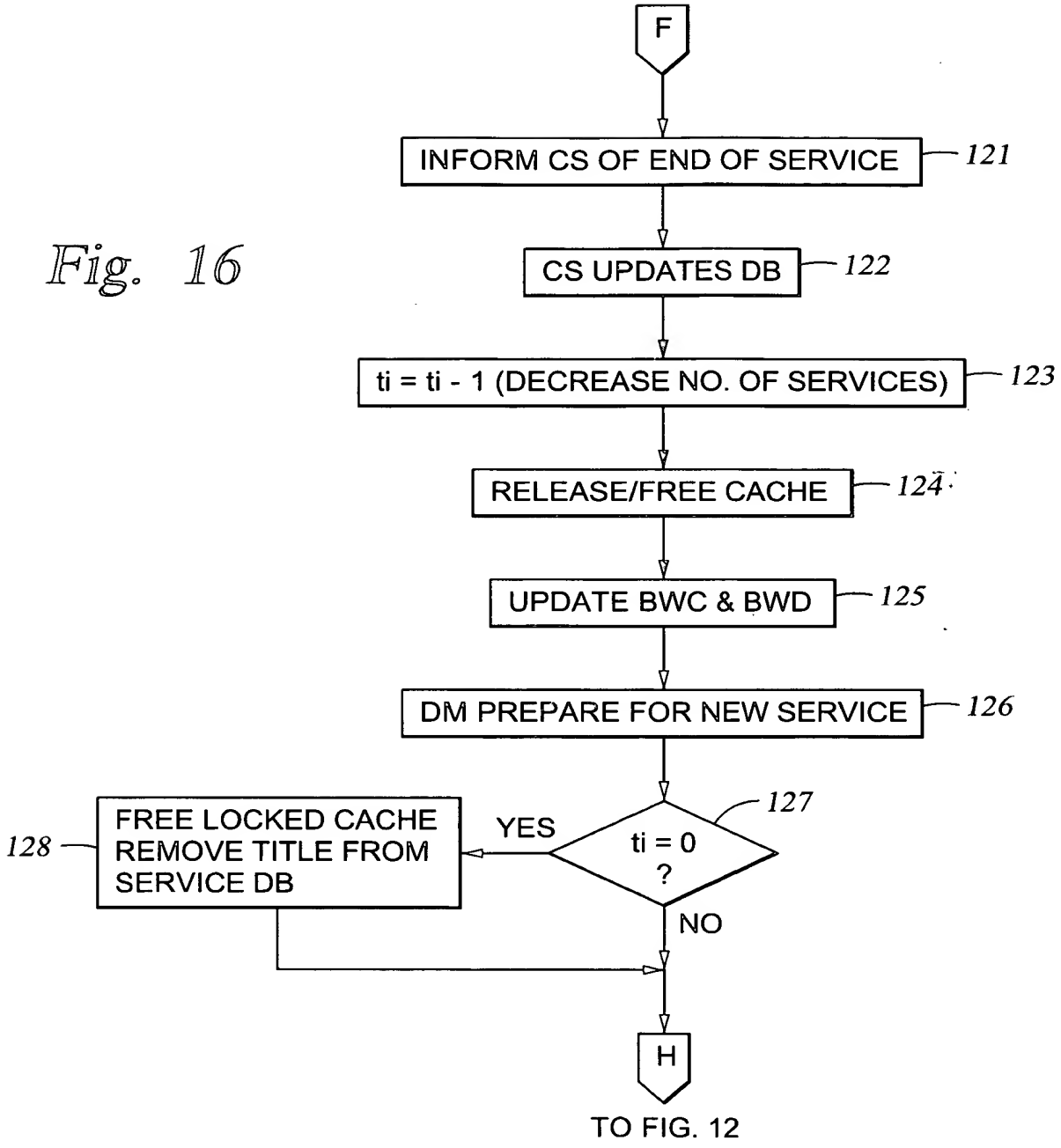

E
101
IS Mi IN DMj LOCAL CACHE ?
YES
NO
102
IS Mi IN ANY DMk LOCAL CACHE ?
NO
YES
103
REQUEST ACCESS TO DMk LOCAL CACHE
104
IS REQUEST GRANTED ?
NO
YES
106
IS OTHER DMk AVAILABLE ?
YES
NO
105
START TRANSFER OF Mi FROM DMk TO DMj
G
TO FIG. 17
TRY FROM OTHER DM IN THE SAME RATING CLASS.
REJECTION CAN BE DUE TO Mi NOT IN DMk CACHE, OR DMk HAS NO BW OR CPU AVAILABLE
107
HAS DMj AVAILABLE BW/CPU TO SERVE ?
YES
NO
G
TO FIG. 17
DATA MOVER DENIES SERVICE (INFORM CS)
108
CS WARNS OPERATOR & UPDATE DB UPDATE MODEL
109
DENY SERVICE TO USER
110
LOG DATA
111

Fig. 15

Fig. 16


F
INFORM CS OF END OF SERVICE
121
CS UPDATES DB
122
ti = ti - 1 (DECREASE NO. OF SERVICES)
123
RELEASE/FREE CACHE
124
UPDATE BWC & BWD
125
DM PREPARE FOR NEW SERVICE
126
127
ti = 0 ?
YES
128
FREE LOCKED CACHE
REMOVE TITLE FROM
SERVICE DB
NO
H
TO FIG. 12

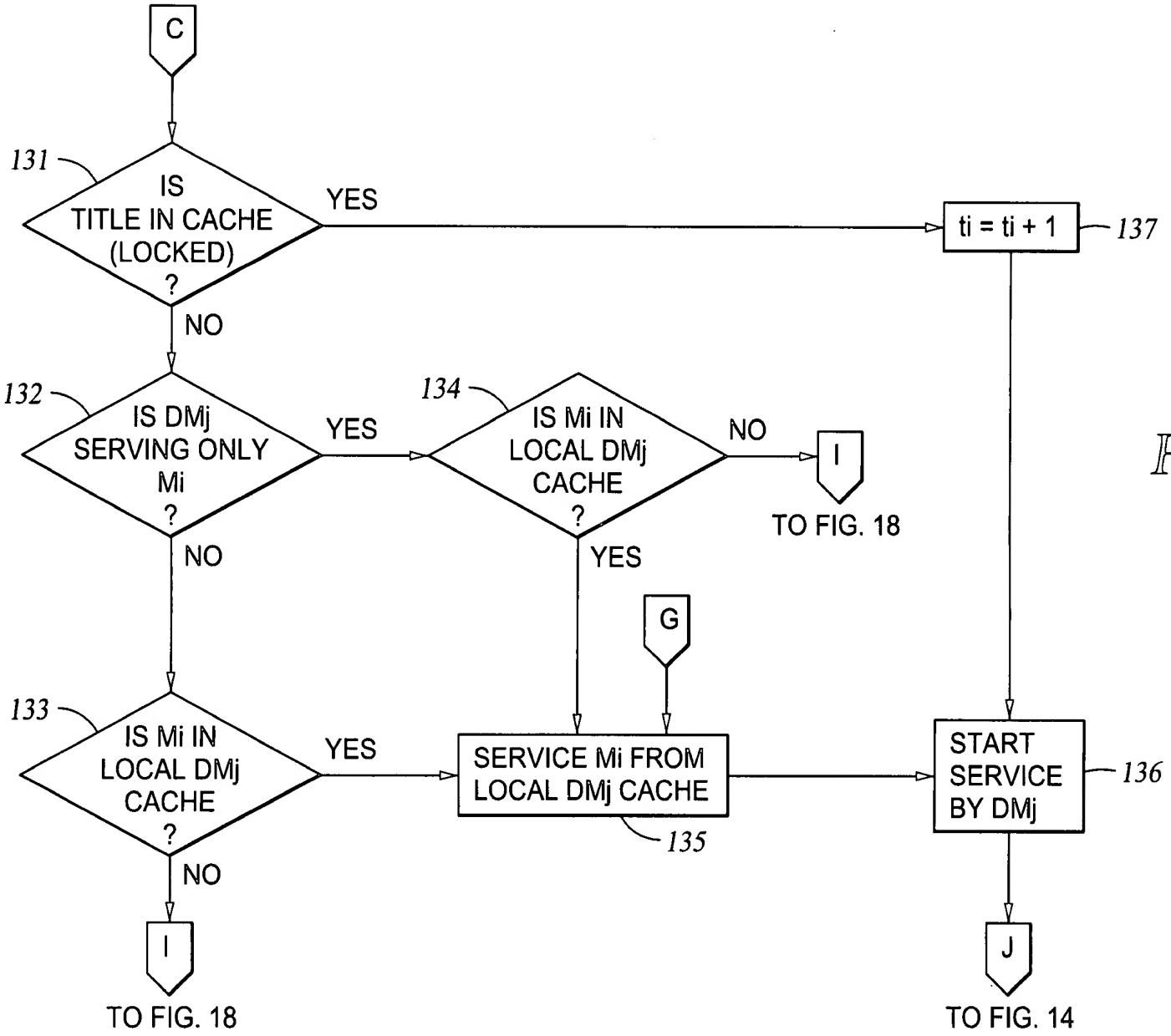

C
131
IS TITLE IN CACHE (LOCKED) ?
YES
ti = ti + 1
137
NO
132
IS DMj SERVING ONLY Mi ?
YES
134
IS Mi IN LOCAL DMj CACHE ?
NO
I
TO FIG. 18
NO
YES
G
133
IS Mi IN LOCAL DMj CACHE ?
YES
SERVICE Mi FROM LOCAL DMj CACHE
135
START SERVICE BY DMj
136
NO
I
TO FIG. 18
J
TO FIG. 14

Fig. 17

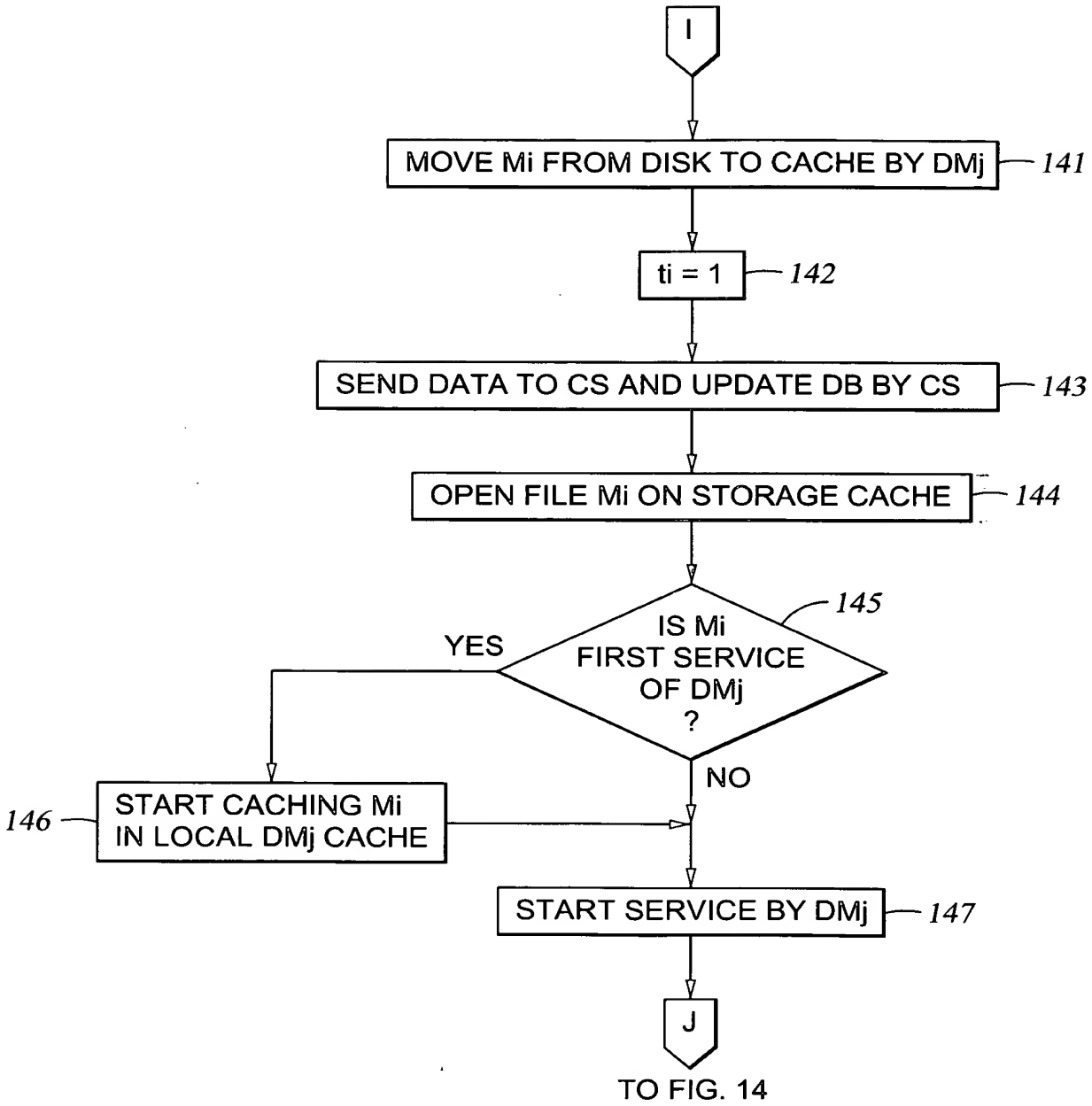

I
MOVE Mi FROM DISK TO CACHE BY DMj
141
ti = 1
142
SEND DATA TO CS AND UPDATE DB BY CS
143
OPEN FILE Mi ON STORAGE CACHE
144
145
IS Mi FIRST SERVICE OF DMj ?
YES
NO
146
START CACHING Mi IN LOCAL DMj CACHE
START SERVICE BY DMj
147
J
TO FIG. 14

Fig. 18

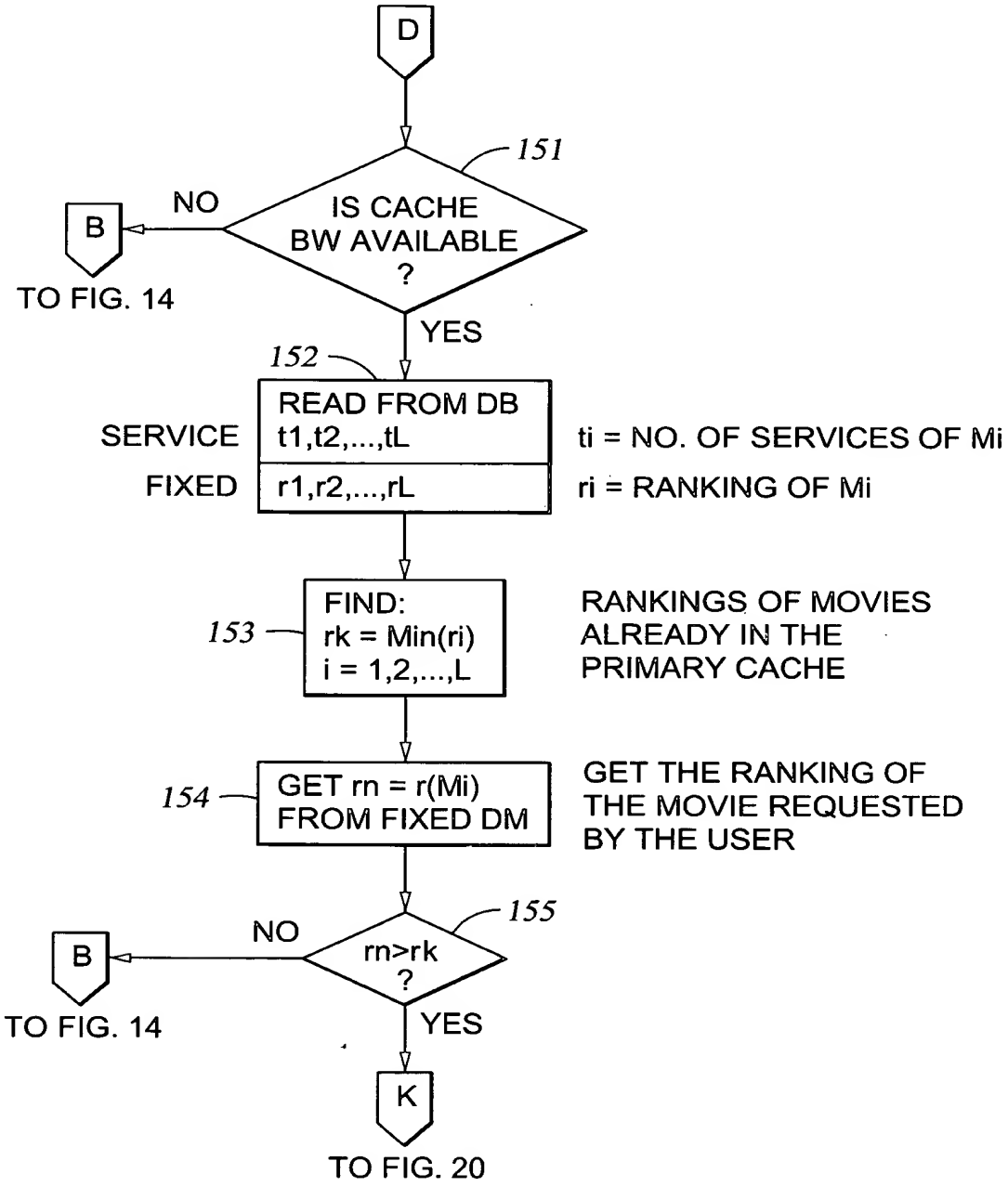

D
151
IS CACHE BW AVAILABLE ?
NO
B
TO FIG. 14
YES
152
READ FROM DB
SERVICE t1,t2,...,tL
FIXED r1,r2,...,rL
ti = NO. OF SERVICES OF Mi
ri = RANKING OF Mi
153
FIND:
rk = Min(ri)
i = 1,2,...,L
RANKINGS OF MOVIES ALREADY IN THE PRIMARY CACHE
154
GET rn = r(Mi) FROM FIXED DM
GET THE RANKING OF THE MOVIE REQUESTED BY THE USER
155
rn>rk ?
NO
B
TO FIG. 14
YES
K
TO FIG. 20

Fig. 19

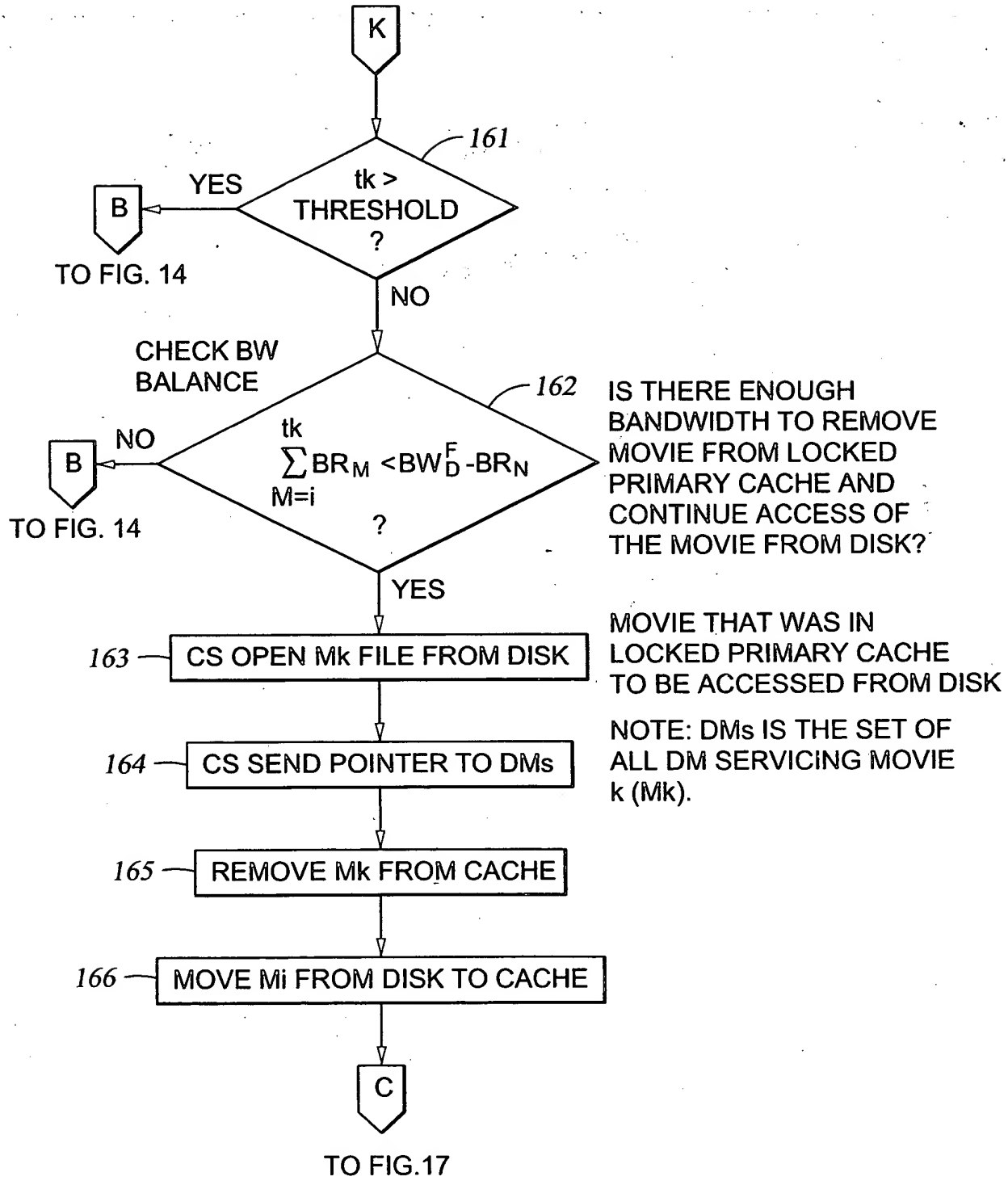

K
161
tk > THRESHOLD ?
YES
B
TO FIG. 14
NO
CHECK BW BALANCE
162
tk
$\sum_{M=i} BR_M < BW_D^F - BR_N$
?
NO
B
TO FIG. 14
IS THERE ENOUGH BANDWIDTH TO REMOVE MOVIE FROM LOCKED PRIMARY CACHE AND CONTINUE ACCESS OF THE MOVIE FROM DISK?
YES
163
CS OPEN Mk FILE FROM DISK
MOVIE THAT WAS IN LOCKED PRIMARY CACHE TO BE ACCESSED FROM DISK
164
CS SEND POINTER TO DMs
NOTE: DMs IS THE SET OF ALL DM SERVICING MOVIE k (Mk).
165
REMOVE Mk FROM CACHE
166
MOVE Mi FROM DISK TO CACHE
C
TO FIG.17

Fig. 20